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(54) Pressure-change adsorption plant for separating mixtures of gases

(57) A pressure-change adsorption plant for separating mixtures of gases consists of adjacently disposed adsorbers 1, 2, 3, a gas mixture storage vessel 6 and a product gas storage vessel 7, wherein directly at the inlet ends of the adsorbers and at the gas mixture storage vessel there is a common first valve block 4 and directly at the outlet ends of the adsorbers and at the product gas storage vessel there is a common second valve block 5 there being inside the first valve block a first gas line 11 leading from a storage vessel 6 to all adsorbers while within the second valve block there is a second gas line 13 leading from all adsorbers to the product gas storage vessel 7.

The two valve blocks 4, 5 each have a cruciform branched connection (Fig. 1) which discharges into tube ends which, together with a pneumatically actuated diaphragm, constitute the adsorber valves 9.

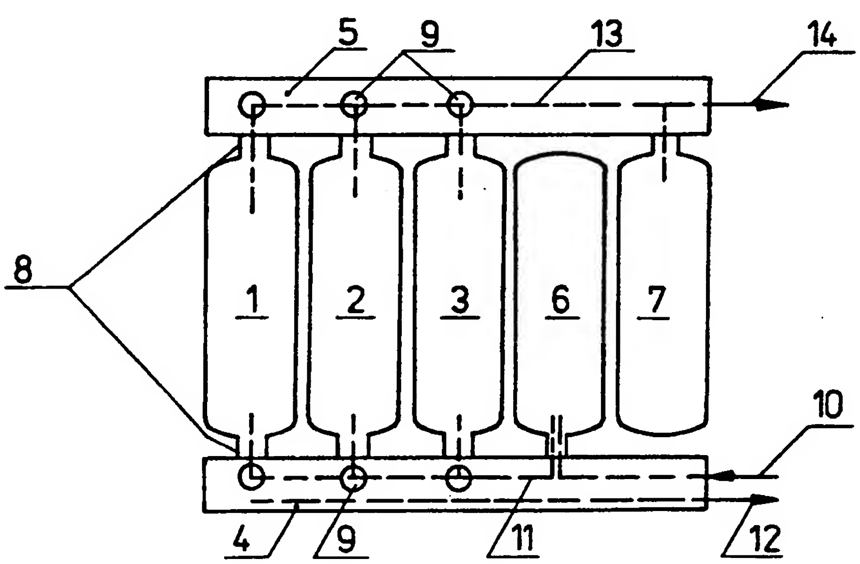

Fig. 2

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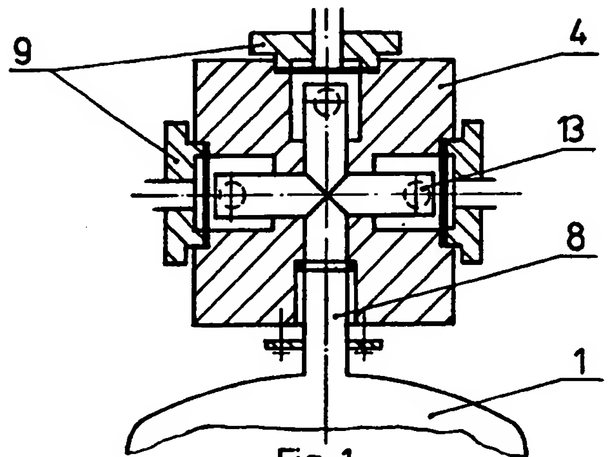

Fig. 1

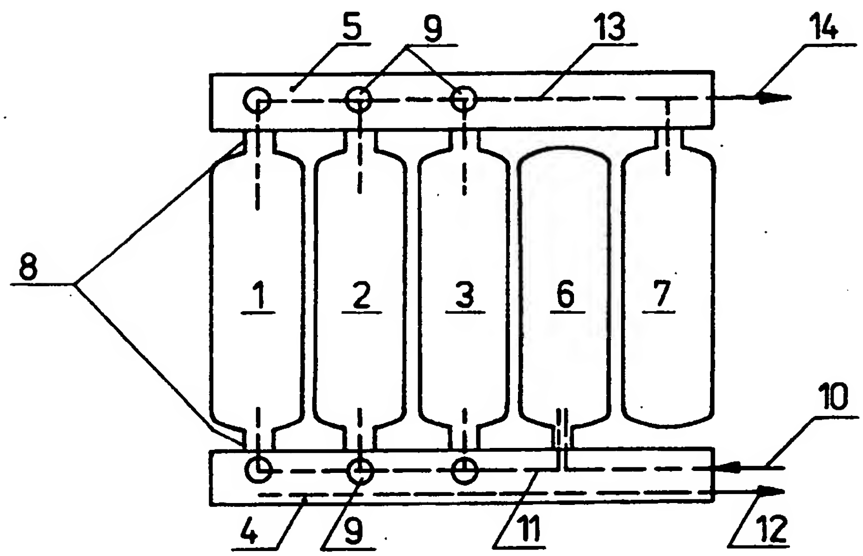

Fig. 2

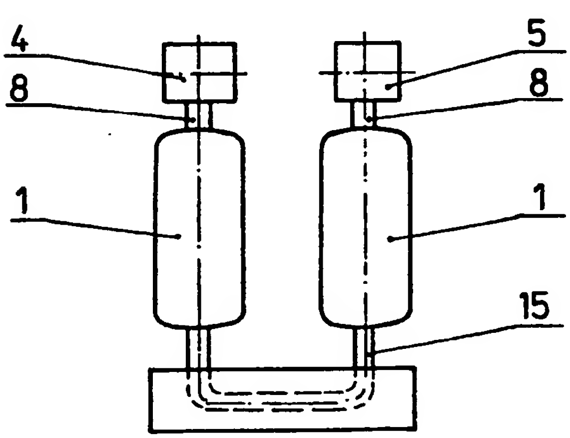

Fig. 3

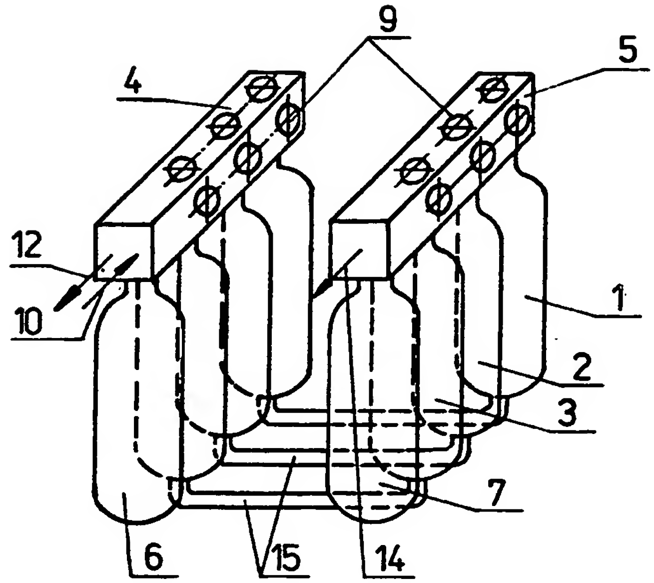

Fig. 4

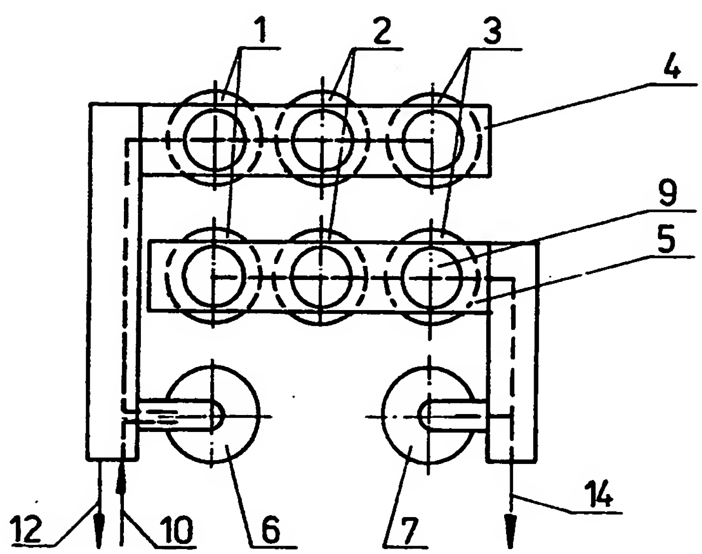

Fig. 5

Pressure-change adsorption plant for separating mixtures of gases

The invention is used in the adsorptive decomposition of gas mixtures, particularly in the recovery from the air of oxygen or nitrogen.

For separating mixtures of gases, for example in order to recover oxygen or nitrogen from the air, adsorption plants are frequently used. By virtue of their economy, plants are preferred which work with changing pressure and these are termed pressure-change adsorption plants. Where these plants are concerned, adsorption and desorption take place at different pressures. With increasing pressure the adsorption process takes place and at falling pressure the desorption takes place, followed in most cases by a flushing of the adsorption agent with the pure gas obtained. In order to be able to carry out the processes one after another, the pressure-change adsorption plants have to comprise a plurality of adsorbers and a plurality of valves. These valves considerably increase the costs and material expense involved. The endeavour is to reduce the costs occasioned by the valves.

Thus, it is known from DE-OS 3310759 to connect respectively to the gas inlet and to the gas outlet of the adsorber a valve unit comprising valves integrated into the main connecting lines. The valve unit on the gas outlet connector is linked by a separate gas line to the buffer tank for product gas. The configuration of such a valve unit and the disposition of the connecting lines are not however described in DE-OS 3310759.

DE-PS 265806 suggests a valve unit for pressure-change adsorption plants which is of block-shaped construction. This valve block contains adsorber gas lines in which the adsorber valves are disposed. In this case, each adsorber valve is connected to a product gas line via a cruciform branched connection. Each product gas line leads via the cruciform branched connection to a plurality of adsorber valves disposed in various adsorber gas lines and is thus connected to all the adsorber valves. The adsorber gas lines lead from the valve unit to the adsorbers so that the valve unit communicates with all the adsorbers via these adsorber gas lines. The valve units are additionally connected via separate gas lines to the gas mixture storage vessels or the product gas storage vessels. A disadvantage is that these gas lines increase the weight of the pressure-change adsorption plant and the probability of leakages.

The aim of the invention is to reduce the costs and material expense entailed by pressure-change adsorption plants and to reduce the amount of space required and also the weight of the plants.

The invention is based on the problem of so devising the disposition of the valve units, adsorbers, gas mixture storage vessel and product gas storage vessel in relation to one another that the gas lines between these parts of the apparatus are shortened as much as possible.

According to the invention, the problem is resolved in that the adsorbers, the gas mixture storage

vessel and the product gas storage vessel are combined into one container block and in that a first joint valve block is disposed directly at the inlet ends of the adsorbers and of the gas mixture storage vessel while a second common valve block is disposed directly at the outlet ends of the adsorbers and of the product gas storage vessel. Provided within the first valve block is a first gas line leading from the gas mixture storage vessel to all the adsorbers while there is within the second valve block a second gas line leading from all the adsorbers to the product gas storage vessel. In this way, the gas from the gas mixture storage vessel flows directly into the first valve block, out of the valve blocks directly into the adsorbers, out of the adsorbers directly into the valve blocks and out of the second valve block directly into the product gas storage vessel. There are no gas lines between the adsorbers, the gas mixture storage vessel and the product gas storage vessel on the one hand and the valve blocks on the other.

Expediently, the adsorbers comprise at their inlet and outlet ends an intermediate adaptor which is disposed directly on the relevant valve block. In the adaptor there are filtering means and possibly also spring means. The filter means prevent the adsorption agent entering the valve block while the spring means compress the adsorption medium.

A further development envisages also the gas mixture storage vessel having at its inlet end and at its outlet end an intermediate member which is disposed directly on the first valve block. Similarly, the product gas storage vessel has at its inlet end and at its outlet end an intermediate member or adaptor which is disposed directly on the second valve block. In a particular embodiment of the pressure-change adsorption plant, the adsorbers consist of two adsorber parts. These are

disposed vertically alongside each other and are connected by a connecting line. This embodiment permits of a space-saving construction of the pressure-change adsorption plant. The invention provides the advantage that separate gas lines between the adsorbers, the gas mixture storage vessel and the product gas storage vessel on the one hand and the valve blocks on the other are unnecessary, so that the pressure-change adsorption plant becomes lighter in weight and more compact.

The invention will be explained in greater detail hereinafter with reference to an embodiment shown in the accompanying drawings, in which:

Fig. 1 shows the cross-section through a valve block,

Fig. 2 shows a longitudinal section through a pressure-change adsorption plant with undivided adsorbers,

Fig. 3 shows the cross-section through a pressure-change adsorption plant with divided adsorbers,

Fig. 4 is a perspective view of a pressure-change adsorption plant with divided adsorbers and

Fig. 5 is a plan view of a pressure-change adsorption plant with divided adsorbers in which the valve blocks are provided with end plates.

The pressure-change adsorption plant described is used for recovering oxygen from the air. The gas mixture to be separated is therefore air in this example. The core of the pressure-change adsorption plane is constituted by the first adsorber 1, the second adsorber 2 and the third adsorber 3. These three adsorbers are disposed directly on the first valve block 4 and on the second valve block 5. Furthermore, there is directly at the first valve block 4 the gas mixture storage means 6 while the product gas storage vessel 7 is disposed on the

second valve block 5. The three adsorbers 1, 2, 3 are at their inlet ends directly connected to the first valve block 4 while their outlet ends are directly connected to the second valve block 5. The connection of the three adsorbers 1, 2, 3, the gas mixture storage vessel 6 and the product gas storage vessel 7 to the two valve blocks 4, 5 is effected in each case via the cylindrical intermediate member 8. These intermediate members 8 are in each case fixed in gas-tight fashion (welded) to the inlet and outlet ends of the adsorbers 1, 2, 3 on the gas mixture storage vessel 6 and on the product gas storage vessel 7, project into a valve block 4, 5 and are bolted to these latter. In this way, a rigid, gas-tight connection is created between the two valve blocks 4, 5 and the said parts of the apparatus. Provided in each of the intermediate members 8 which are fixed on the three adsorbers 1, 2, 3 are respective filters which prevent the emergence of adsorption medium into the valve blocks 4, 5. Furthermore, at the outlet ends of the three adsorbers 1, 2, 3, the clamping means for the end piece which defines the layer of adsorption medium projects into the intermediate members 8.

The intermediate members 8 are constructed to be as short as is technically possible, i.e. as short as is required by a screwed connection using stud bolts which are let into the valve blocks 4, 5. With other embodiments, the length of the intermediate member 8 may be determined by the size of the incorporated fitments which it is intended to dispose in the intermediate member 8.

The length of the intermediate members 8 amounts to a maximum 10% of the length of the adsorbers 1, 2, 3 or of the gas mixture storage vessel or product gas storage vessel 7. In this way, the three adsorbers 1, 2, 3, the gas mixture storage vessel 6 and the product gas storage

vessel 7 are disposed directly on the valve blocks 4, 5 or on one of the two valve blocks 4, 5. Furthermore, in this way, the three adsorbers 1, 2, 3, the gas mixture storage vessel 6 and the product gas storage vessel 7 are combined into one container unit.

The two valve blocks 4, 5 are constructed substantially in the manner described in DD-PS 265806. They have the form of a parallelepiped block with a rectangular base area. As Fig. 1 shows, the two valve blocks 4, 5 have at those places where the three adsorbers 1, 2, 3 and the gas mixture storage vessel 6 and product gas storage vessel 7 are disposed, a cruciform branched connection. These branched connections are in each case connected via a passage to the intermediate member 8 so that gas can flow out of the adsorbers 1, 2, 3, the gas mixture storage vessel 6 and the product gas storage vessel 7 into the relevant branched connection or vice versa. The branched connections discharge in each case into two or three tube ends which, together with a pneumatically actuated diaphragm, constitute the adsorber valves 9. Three of these adsorber valves 9 are shown in Fig. 1.

At the place where the said tube ends are located, there are machined into the two valve blocks 4, 5 cylindrical recesses which, together with the tube ends, form an annular gap. The area of such an annular gap corresponds thereby to the area of the interior cross-section of the tube ends. Both valve blocks 4, 5 have in their longitudinal direction two or three gas lines which connect to one another three adsorbers 1, 2, 3 and the gas mixture storage vessel 6 and the product gas storage vessel 7. The cylindrical recesses are a constituent part of these gas lines. The axes of the tubes leading to the cruciform branched connections intersect the axis of a gas line.

As Fig. 2 shows, one of the gas lines disposed in the first valve block 4 is connected to the compressed air line 10. This gas line which is connected to the compressed air line 10 constitutes the first gas line 11. It extends over the total length of the first valve block 4. It connects the compressed air line 10 to the gas mixture storage vessel 6 and the three adsorbers 1, 2, 3 and thus also connects the gas mixture storage vessel 6 to the three adsorbers 1, 2, 3. The compressed air line 10 serves to feed the gas mixture - air - from which it is intended to recover the oxygen by adsorption.

Disposed in the first valve block 4, in the first gas line 11, is a filter which projects into the intermediate member 8 which is associated with the gas mixture storage vessel 6. The air coming from the compressor through the compressed air line 10 flows through the filter into the gas mixture storage vessel 6 and from there through the intermediate member 8 which is associated with the gas mixture storage vessel 6, through the first gas line 11 and through the adsorber valve 9 associated with the appropriate adsorber 1, 2, 3 and into that one of the three adsorbers 1, 2, 3 where the adsorption process is taking place.

Another gas line of the first valve block 4, which likewise extends over the entire length of this valve block, is connected to the residual gas line 12. However, this gas line is not connected to the gas mixture storage vessel 6. The residual gas occurring in the adsorbers 1, 2, 3 during the desorption or flushing process leaves the first valve block 4 through the residual gas line 12. The residual gas passes thereby out of the relevant adsorbers 1, 2, 3 into the intermediate member 8 disposed at this adsorber subsequently into the gas line disposed in the first valve block 4 and connected to the residual gas line 12 and then into the residual gas line 12.

Via the second gas line 13 which is disposed in the second valve block 5, the three adsorbers 1, 2, 3 are connected both to one another and also to the product gas storage vessel 7. In the second gas line 13, between the three adsorbers 1, 2, 3 and the product gas storage vessel 7 there is a non-return valve which prevents oxygen flowing back from the product gas storage vessel 7 into the three adsorbers. The oxygen recovered is stored in the product gas storage vessel 7. The oxygen separated during the adsorption process leaves the relevant adsorber through the intermediate member 8 associated with this adsorber and through the associated adsorber valve 9 passing into the second gas line 13 which leads to the product gas storage vessel 7, passing then through this gas line and through the non-return valve to arrive at the product gas storage vessel 7. The second gas line 13 is connected to the product gas line 14 through which the oxygen coming from the product gas storage vessel 7 leaves the pressure-change adsorption plant. This product gas line 14 comprises a valve with which the oxygen draw-off from the product gas storage vessel 7 is regulated. The other gas lines disposed in the second valve block 5 connect the three adsorbers 1, 2, 3 to one another.

In the case of the plant shown in Fig. 2, the two valve blocks 4, 5 are opposite each other, i.e. above and below the adsorbers 1, 2, 3, the gas mixture storage vessel 6 and the product gas storage vessel 7. Such an embodiment is preferably chosen for relatively large pressure-change adsorption plants.

In the case of an embodiment as shown in Figs. 3 and 4, the three adsorbers 1, 2, 3 are of divided construction and the two valve blocks 4, 5 are disposed horizontally beside each other. The two adsorber parts are thereby connected to each other by the connecting line 15 through which gas flows from one adsorber part into the

other adsorber part. This embodiment is chosen for smaller pressure-change adsorption plants in which is it desired to save space.

An embodiment of the pressure-change adsorption plant with the rectangular base area is shown in Fig. 5. In this case, the three adsorbers 1, 2, 3 are also of divided construction and the two valve blocks 4, 5 are horizontally adjacent each other. Disposed on each of the two valve blocks 4, 5 is an end plate and the end plates likewise comprise gas lines which are connected to the gas lines of the valve blocks 4, 5. The gas lines in the end plate associated with the first valve block 4 lead to the inlet ends of the three adsorbers 1, 2, 3. The first gas line 11 which is connected to the compressed air line 10 leads furthermore to the gas mixture storage vessel 6. The second gas line 13 in the end plate which belongs to the second valve block 5 leads to the outlet ends of the three adsorbers 1, 2, 3 and to the product gas storage vessel 7. The two end plates are thus a direct constituent part of the two valve blocks 4, 5.

This embodiment is above all suitable for small pressure-change adsorption plants which require a particularly small amount of space. It is ideally suited if the plant is to be disposed in a relatively small container.

Claims

1. A pressure-change adsorption plant for separating mixtures of gases, and consisting of a plurality of adjacently disposed adsorbers, a gas mixture storage vessel, a product gas storage vessel and valve blocks which contain the adsorber valves, wherein directly at the inlet ends of the adsorbers and at the gas mixture storage vessel there is a common first valve block and directly at the outlet ends of the adsorbers and at the product gas storage vessel there is a common second valve block there being inside the first valve block a storage vessel to all adsorbers while within the second valve block there is a second gas line leading from all adsorbers to the product gas storage vessel.

2. A pressure-change adsorption plant as claimed in claim 1, wherein the adsorbers comprise at their inlet and outlet ends of intermediate member which is disposed directly on the relevant valve block filtering means being provided in the intermediate member.

3. A pressure-change adsorption plant as claimed in claim 1 or 2, wherein the gas mixture storage vessel has at its inlet and outlet end an intermediate member which is disposed directly on the first valve block and in that the product gas storage vessel has at its inlet and outlet end an intermediate member which is disposed directly on the second valve block.

4. A pressure-change adsorption plant as claimed in any one of claims 1 to 3, wherein the adsorbers consist of three adsorber parts which are disposed vertically beside one another and are connected to each other by a connecting line.

5. A pressure-change adsorption plant substantially as described herein by reference to one or more of the figures.

6. The use of a plant as claimed in any preceding claim in separating a gas mixture.

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